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# Knowledge Management System for Cluster Development in Small and Medium Enterprises

Pradorn Sureephong, Nopasit Chakpitak, Yacine Ouzrout, Gilles Neubert and Abdelaziz Bouras

**Abstract**—Many countries such as Canada, Japan, Korea and France gains their competitive advantage through the utilization of clusters development. A cluster contains many Small and Medium Enterprises (SMEs) operating in the same or similar industry strongly connected with each other to produce good and services. In developing country, especially, Small and Medium Enterprises (SMEs) take very important role to their economic. Most governments, as facilitator, support cluster through initiate help and encourage SMEs' linkage to reach the concept of industry cluster.

Many literature reviewed claimed that the most difficult processes in creating a cluster is the development and sustain the collaboration to connect these SMEs together. After some investigation, the problem of creating SEMs connection is information sharing at micro-economic level. Knowledge sharing is one of the most important key success factors of cluster management to gain collaboration among SMEs since there are abundant of explicit and tacit knowledge within each SMEs in a cluster. Naturally, most firms do not want to share their business information and knowledge. In reality, however they needs these information to successfully manage their business cluster. It is crucial and necessary we find out what kind of information or knowledge they want to know and shareable among them in order to manage cluster successfully.

Many operation management techniques already existed in many firms. One of the ways to help knowledge sharing operate successfully using information technology as a tool is directed to Knowledge Management System (KMS). This methods can help facilitate the communication and information flow and needs to be investigated further to help maintain the cluster collaboration and knowledge sharing. This paper propose framework and methodology for analyzing, industry cluster for the sustain the lifecycle of cluster.

*Index Terms*—Knowledge base management system, Industry cluster, management technique, Collaboration.

## I. INTRODUCTION

In developing country, Small and Medium Enterprises (SMEs) are very important to their economy. Therefore, more than 70% of firm in industry sector are small to medium size. So, Government try to support these companies in various ways such as financial support, government policy or import and export promotion. However, large number of SMEs can not survive in competition, not only in local market but also in the world market. Many large enterprises which have lower cost, better management and higher promotion power took important role in the market. After the concept of industry

cluster was popularized by prof. Michael E. Porter in 1990 [1]. Then, SMEs trend to link to each other to maintain their competitiveness in their market. The first benefit that firm gains from being a member of cluster is surviving in competition in local and world market. But, the others advantages are depend of characteristic of collaboration in each cluster. Regarding to alteration in competition and innovation in the world market, industry cluster requires various knowledge, such as process, market, information and technology, which is subject to their products. Successful companies can be expected to anticipate nascent customer's need with innovative product or meet existing need with the newest, most efficient process and technology [2] which required considerable amount of knowledge. These all knowledge was collected in form of tacit and explicit knowledge in peoples and institutions within cluster. Thus, applying knowledge management theory to cluster development should assist industry cluster to be able to achieve goal of collaboration efficiently.

Although, many papers claimed that knowledge is very important for cluster development but only few of them claimed about empirical method to initiate or improve knowledge sharing for cluster. The objective of this paper is proposing a framework for implementing KMS to existed industry cluster. The proposed framework was divided into 4 phases. As we are in the beginning of the study, this paper will mention about the process and methodology which will be used in future work. At the end of the study, we will propose methodology for implementing KMS and information system for industry cluster.

## II. INDUSTRY CLUSTER

### A. Industry Cluster Characteristic

The concept of industry clusters was popularized by Prof. Michael E. Porter in his book named "Competitive Advantages of Nations" [1]. Then, industry cluster becomes currently trend in economic development planning. However, there is considerable debate regarding the definition of an industry cluster, how to identify industry cluster, or what factors drive the development of an industry cluster.

According to Doeringer and Terkla, there is no single definition of an industry cluster. From the most simplistic view, industry cluster is "geographical connections of industries that gain performance advantages through co-location" [3]. Rosenfeld has enlarged the connections to those companies that also provide complementary services, including consultants, education and training providers, financial institutions,

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professional associations and government agencies. An industry cluster is "a geographically bounded concentration of similar, related or complementary businesses, with active channels for business transactions, communications and dialogue that share specialized infrastructure, labor markets and services, and that are faced with common opportunities and threats" [4]. And also, Porter had identified industry cluster later in his book named "On Competition" [5] as a geographically proximate group of companies and associated institutions in a particular field, linked by commonalities and complementarities.

Moreover, he had provided a simple definition of two types of clusters: vertical clusters, and horizontal cluster. *Vertical clusters* are made up of industries that are linked through buyer-seller relationship. *Horizontal cluster* include industries which might share a common market for the end products, use a common technology or labor force skills, or require similar natural resource [1].

Factors that drive industry cluster development and growth are also the subject of debate in the literature. Porter pointed out that the competition is a driving force behind cluster development. Clustering is a dynamic process, and as one competitive firm grows, it generates demand for other related industries. The author claims that it is the competition between rival firms in the cluster that drives growth because it forces firms to be innovative, and to improve and create new technology for customers. An increasing in vertical integration occurs when labor gets more specialized and new firms are able to fill the new niche market. And, horizontal clustering occurs when new technology and labor skills are applied to related industries in different sectors [1].

### B. Knowledge Management and Cluster Development

Knowledge Management (KM) is one of the key process factors in organizations. It aims to capture explicit and tacit knowledge of organizations. According to Arbones and Moso [6], knowledge cluster is a network of universities, business schools, management consultants, and other service providers including agencies, public body promoting economic development and, lastly companies and their association. But for our study, knowledge cluster is not only network of educational institution and companies but also capable to manage explicit and tacit knowledge within the cluster, in order to facilitate its access, sharing out and reuse.

Knowledge management system is distributed hypermedia system for managing knowledge in organization, supporting creation, capture storage and dissemination of expertise and knowledge [7]. This is new management technique for cluster development that aims to increase the capability of companies to learn and gain knowledge through collaboration. In addition, knowledge cluster is a meeting point to search for new knowledge and then leveraging this knowledge for companies to exploit.

### C. Management Techniques and Cluster Development

In present rivalry, firms try to improve their products and services by utilizing many management techniques in order to reach customer's satisfaction. These techniques such as Supply Chain Management (SCM), Value Chain Management (VCM), Product Life-cycle Management (PLM) or Customer Relationship Management (CRM) may take part in cluster development unavoidable. Although, industry cluster and management techniques are in different economic point of view, industry cluster can be compared with macro-economic aspect which is involved in policy level but management techniques are more in micro-economic aspect, however there are some focal points between these two aspects. For example, in vertical type of cluster which are made up of industries that are linked through buyer-seller relationship as same as relationship in supply chain. Thus, supply chain or value chain analysis tools could be useful to analyze relationship of chains within the cluster. By utilizing benefit of Knowledge Management System (KMS), these management techniques could be applied to industry cluster development processes. For example, PLM and CRM could be integrated to KMS in term of market places, customer feedback, and product information sharing between firms in the chain.

### D. Thailand's Government and Cluster Development

Small and Medium Enterprises (SMEs) have played a very important role in Thailand's economy because more than 90% of total number of establishments in manufacturing sector in Thailand are SMEs. Moreover, they employed about 65% of industrial workers. Thailand's government also gives numerous advantages to support SMEs such as tax reduction, establish SME Bank and assist the clustering of companies in SMEs to increase competitiveness in the world market, for example One Tambon One Product (OTOP) project was established to increase productivity of small enterprise level in all sub-region of Thailand. Therefore, most of assemblies of Thai's SMEs in term of industry cluster are facilitated by government organization.

By clustering of SMEs will bring various advantages to participants such as, product innovation, value added for product and knowledge and information sharing, which would create competitiveness in world market. So that, supporting collaboration within the cluster is important role in cluster development, this will create positive impact to Thailand's economy and competitiveness of country.

From literature reviewed, many studies described success stories or case studies for industry cluster initiation and development in many regions. Many critical success factors of cluster development and the benefits of clustering have been written and reported, but there has been little work discussed about obstacles for cluster development. Moreover, most of them are more in term of policy than framework due to the difference of characteristic, objective of collaboration, definition of cluster and so on. Especially, very few of studies tried to merge industry cluster with knowledge management or operation management techniques. So that, this study will

propose framework and methodology for implementing management techniques and knowledge management system for cluster development.

### III. METHODOLOGY

There is ambiguity in cluster development and benefit from being a member of cluster. According to Rosenfeld [8], cluster development can be done in various ways depend on characteristic of cluster and propriety. Participants will gain benefit from being member of cluster through collaboration. So that, supporting collaboration within cluster is very essential role in cluster development in regional.

As we described that proposed methodology was focused on existed cluster which is in developing process. However, we presented methodology for industry cluster initiation in implementing phase in proposed framework. The framework for this study, was separated in to four main phases as shown in figure 1,

#### A. Analyzing Phase

Industry clusters are generally identified through the use of quantitative analysis techniques and qualitative analysis techniques. Quantitative techniques such as shift-share analysis, location quotient and payroll data which are economic based analysis techniques. They are able to identify the economic impact from establishing for each industry, growth and decline, or concentrations of industries within a region. While quantitative analysis will indicate the presence of the cluster, they do not address whether there is really a functional or dynamic relationship between industries [9]. So that, it is necessary to supplement quantitative analysis with qualitative techniques, such as, porter's diamond model or value analysis. The qualitative will help to determine what type of relationship between industries within the cluster, and will help to identify industry clusters that may be overlooked by conventional data analysis. Most industry cluster research to date has been based on quantitative analysis [9].

1) *Quantitative Analysis*: The objectives of quantitative analysis are to evaluate economic impact of specified cluster to nations, understand which industries are growing and which are declining, and how competitive of regional industries compared with their counterparts nationally. Porter also relied heavily in this type of analysis. Economic based analysis is an appropriate tool to analysis the cluster in term of quantity. Economic based concepts originated with the need to predict the effect of new economic activity on cities or regions. Economic based model focus on the demand side of economy but they ignore the supply side, or productive nature of investment, and are thus short-run in approach. For Example, employment trends, establishment trend, regional employment comparison, unemployment and labor force trends, etc.

Hubert H. Humphrey Institute of Public Affairs of the University of Minnesota has developed HHH framework which is for "understanding your industries" [10]. This framework has proposed economic based analysis method into 7 steps.

Step	Method	Objective(To determine)
1	Share of Location Employment	each industry's share of employment within its sector
2	Change in Employment	growth in employment of industry
3A	Location Quotient	Industry's connection in an area relative to rest of nation change of its concentration relative to other areas
3B	Change in Location Quotient	
4	Shift-Share Analysis - National Share - Industry Mix - Competitiveness Analysis	competitiveness of industries national growth in employment growth in industry mixed ability of regional economy to capture a growing share
5	Analysis of Payroll Data	key industries in region to employment data
6	Analysis of Earning Data	economic output generated within a region
7	Analysis of Firm Number Data	economic activity in a given industry is concentrated

TABLE I  
SHOW 7 STEPS OF HHH FRAMEWORK

As we desired to use handicraft industry in Thailand to be our case study, all the economic statistic data in Thailand are categorized by using ISIC Rev.3 Standard (International Standard Industrial Classification of all economic activities: third revision). Then, identification of all activities about handicraft cluster in term of ISIC Rev.3 standard will help to access economic and statistical data easier [11]. Moreover, using standard format is suitable for comparison with data from foreign countries. In the primary study, we have classified handicraft cluster in to 6 main groups, based on number code of ISIC Code. For examples, ISIC code numbers 17xx - 21xx are Textile, Apparel, Lather Product, Wood Product and Paper Product consequently, jewelry is ISIC code number 3691.

2) *Qualitative Analysis*: There are many ways for analyzing in term of quality such as peer review, interview, survey focus group with key industry representative, or using analysis tools such as porter's diamond model. This kind of analysis depend on characteristic of each industry. And, the result of analysis is also depend on many variables e.g. experience of analyzer, design of analysis or tools and techniques. This paper will explain about a general tools which always be used to analyze industry cluster.

Porter's Diamond Model is one of well known technique to determine which firms and industry had competitive advantages, and emphasize the importance of related and supporting industries encouraged interest in cluster. This model is also known as "Diamond of Advantage" [1].

*Factor Conditions*: The situation in a country regarding production factors, like skilled labor, infrastructure, etc., which are relevant for competition in particular industries. Example: Lack of funding support for brand building initiatives.

*Home Demand Conditions*: The more demanding of customers in an economy, the greater pressure facing firms to constantly improve their competitiveness via innovative products, high quality, etc. Example: Lack of demand for good

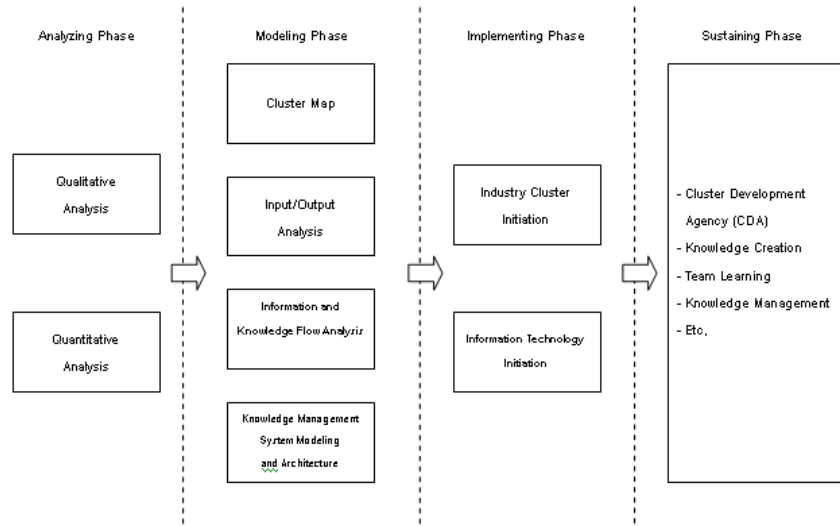


Fig. 1. Proposed methodology for cluster development

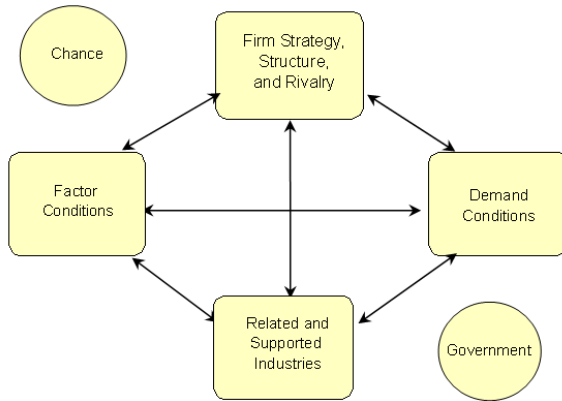


Fig. 2. Porter's diamond model

quality product.

**Related and Supporting Industries:** Competitive supplying industries will reinforce innovation and internationalization in industry at later stages in value system. Example: Lack of technology support and know how.

**Firm Strategy, Structure, and Rivalry:** The condition in the country that determines how companies are established, are organized and are managed and that determined the characteristics of domestic competition. Example: Lack of market intelligence center.

### B. Modeling Phase

The objectives of this phase are to understand characteristic and environment of cluster, identify the role of members and participants within the cluster, understand information and knowledge flow with in the cluster, and to model knowledge management system which support all necessary activities in the cluster. We could divide this phase into 4 processes from understanding to modeling industry cluster. In the highest

level, cluster map is a general tool that be used to identify environment and participant of the cluster. After that, Input/output analysis would explain more details about relationship of industry within the cluster. Then, Information and knowledge flow model will show information and knowledge which is exchanged within cluster, environment and between cluster. Lastl y, knowledge management system architecture is be designed to support all information and knowledge sharing, and collaborative activities in the cluster.

- **Cluster Map:** Diagram of industry cluster map(as shown in figure 3) will help us to understand characteristic, components and environment of cluster.
- **Input-Output Analysis:** Input-output analysis is an analytical tool to analyze inter-industry relations in an economy. These relations describe how the output of one industry goes to another industry where it serves as an input, and thereby makes one industry dependent on other both as customer of output and as supplier of inputs. An input-output model is a specific formulation of input-output analysis. The methodology is complex but it is based on input-output table that records transaction between industries. The I/O table allows us to examine the linkage between local industries and the impact of various industries on the local economy as a whole. These are important step in determining the mark up of cluster and the drivers in local economy.
- **Knowledge and Information Flow Model:** The objective of this process is to model knowledge and information flow within the cluster and between cluster and environment which can be done in various ways such as peer review, input/output analysis. In this process, the Unified Modeling Language (UML) which is a standard language for visualize modeling, can be useful to model relationship of firms within the cluster. All participants in cluster are able to collaborate by two ways as shown in figure 4.

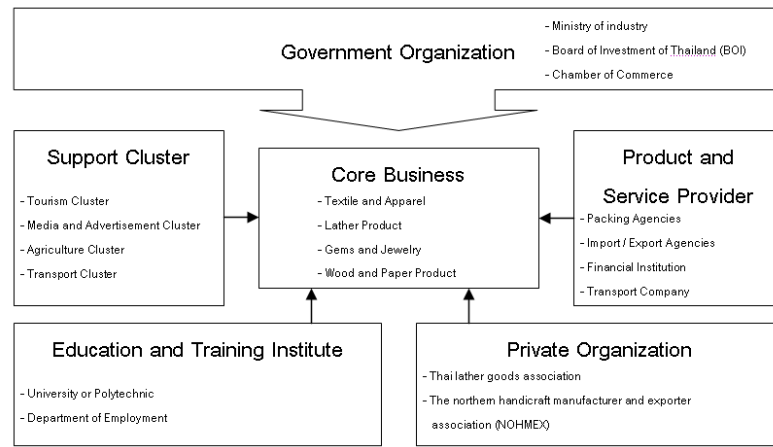


Fig. 3. The industry cluster map with examples

First is physical collaboration or usual activities such as meeting, conference, research and development activity. Second is logical collaboration which is collaboration by sharing knowledge and information through KMS. The logical/virtual collaboration can be the first stage of collaboration before turning to physical collaboration.

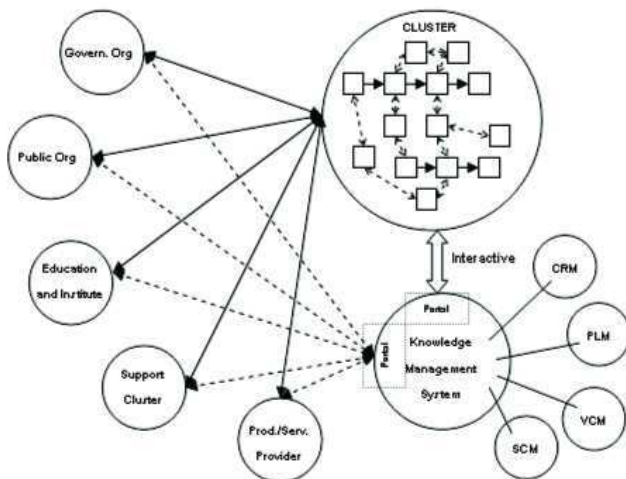


Fig. 4. The outline of information flow model within the cluster

- **Knowledge Management System Architecture**  
This process is the final step for modeling knowledge management system for supporting cluster's activities and information flow within cluster. We also integrated operation management techniques such as supply chain management and value chain management in term of technical support, product description, and value added for product; product lifecycle management can be integrated in term of new product development; customer relationship management can be applied in term of customer's feed back or market place.

### C. Implementing Phase

This phase try to initiate industry cluster and apply information technology system with collaborative activities for the industry cluster.

- **Industry Cluster Initiation**

A recent primer on cluster-based economic development for the Economic Development Administration by Information Design Associates and ICF Kaiser [15] describes that cluster strategy process as consisting of four stages: *Stage 1: Mobilization* - Building interest and participation among different constituencies need to carry out the initiative.

*Stage 2: Diagnosis* - Assessing the industry clusters that comprise the economy and the economic infrastructure that supports cluster performance

*Stage 3: Collaborative Strategy* - Convening demand side stakeholders (companies in each cluster) and supply side stakeholders (public and private supporting economic institution) in working groups to identify priority challenges and action initiatives to address shared problems.

*Stage 4: Implementation* - Building commitment of cluster working group participants and regional stakeholders to actions and identifying or creating an organization to sustain implementation

- **Information Technology Initiation**

Based on system development procedure of Business Process Integration (BPI) by Kobayashi [14], we can divide information technology initiation for cluster into 3 sub-processes as follow.

- 1) The cluster collaboration design process
  - a) Collaboration Specification
  - b) Collaboration Process Design
  - c) Data Model Design
- 2) The system design process
  - a) Input-Output Design
  - b) Interface Design
  - c) Data Specification Design

### 3) The implementation process

#### D. Sustaining Phase

There is an ambiguity about how to make collaboration sustainable. Most of case studies utilized cluster development agencies (CDA) to be facilitator and maintaining collaboration within the cluster. Although, CDA was successful in some case studies but in many case studies indicated that there are many limitations and obstacles for CDA such as strong individualism of entrepreneurs, participation of business owners' fragmentation of business association. Knowledge management and team learning theory could be useful tools to motivate and stimulate collaborative activities within the cluster. According to Nonaka's knowledge creation framework [12], the interactions between the explicit and tacit knowledge lead to the creation of new knowledge.

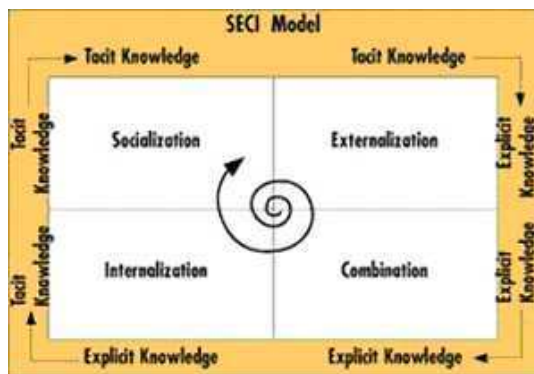


Fig. 5. Nonaka's knowledge creation model

*Socialization:* From tacit to tacit this kind of knowledge sharing is often done without ever producing explicit knowledge. Tools to support such as: e-mail, bulletin boards or brain storming.

*Externalization:* From tacit to explicit by its nature, tacit knowledge is difficult to convert into explicit knowledge. Tools to support such as: semantic network, knowledge ontologies or agent technologies.

*Combination:* From explicit to explicit Explicit knowledge can be shared in meetings, via documents, etc. Tools to support such as: lesson-learned database, tracking or data mining.

*Internalization:* From explicit to tacit In order to act on information, individuals have to understand and internalize it, which involves creating their own tacit knowledge. Tools to support such as: searching, document management or workflow system.

#### IV. CONCLUSION

The concept of industry cluster was interested by government in many countries since 1990. Due to, it was a new idea to increase competitiveness of country. This concept is grouping similar and related industry together. The grouped firm will be called "industry cluster". Objectives of clustering are depend on common interest of firms and characteristic of collaboration within cluster.

Until now, many countries succeeded in cluster initiation but many failed because of different obstacles. However, successful countries do not have any concrete framework or methodology to improve and sustain collaboration of existing cluster. Thus, this study tried to propose framework and methodology for these cluster. Besides, knowledge management techniques and operation management techniques will be integrated in order to enhance collaboration and knowledge sharing for cluster.

This paper proposed prototype framework and methodology from analyzing to sustaining process. For analyzing and modeling phase, we had proposed methodology for each sub-process. But we had proposed an outline for implementing and sustaining phase in consequence of we are focusing in first two phases.

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